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Paper 87-13

**GEOLOGY OF THE WEST-CENTRAL
CAPE BRETON HIGHLANDS, NOVA SCOTIA**

R.A. Jamieson
P. Tallman
J.A. Marcotte
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K.A. Connors

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GEOLOGY OF THE WEST-CENTRAL CAPE BRETON HIGHLANDS, NOVA SCOTIA

Abstract

Mapping of metavolcanic, metasedimentary, and metaplutonic rocks in the vicinity of the Northeast Margaree River, west-central Cape Breton Highlands, has been carried out on 1:10 000 and 1:25 000 scales. The Jumping Brook metamorphic suite (redefined) consists of a lower unit of metabasalts and associated pyroclastic and sedimentary rocks (Faribault Brook metavolcanics), overlain by quartz-rich sedimentary rocks with local conglomerate and tuff (Barren Brook schist), and semi-pelitic to psammitic schists (Dauphinee Brook schist), which grade into porphyroblastic schists ranging up to staurolite-kyanite grade (Corney Brook schist). Medium grained amphibolite (George Brook amphibolite) with relict dioritic texture is common in the sequence and probably represents synvolcanic intrusions. The Belle Cote Road gneiss, an Ordovician-Silurian tonalitic to granodioritic orthogneiss considered part of the Pleasant Bay Complex, forms an elongated belt through the central highlands. These units can be traced from the Cheticamp River into the central highlands in the area bounded by Highland and Fielding roads. They are intruded by a range of foliated to undeformed Silurian to Devonian granitoid rocks. Massive sulphide deposits, common in the vicinity of Faribault Brook, are localized near the transition from metavolcanic to metasedimentary rocks. However, shearing has remobilized sulphides in some deposits, while others are associated with unrelated, later shear zones. The age of the volcanic and sedimentary protoliths of the Jumping Brook metamorphic suite is not known, but a Lower Paleozoic age, previously considered unlikely, now appears possible.

Résumé

On a cartographié, à l'échelle du 1/10 000 et du 1/25 000, les roches métavolcaniques, métasédimentaires et métaplutoniques aux environs de la partie nord-est de la rivière Margaree, dans la partie centrale ouest des hautes-terres du Cap-Breton. L'ensemble métamorphique de Jumping Brook a été redéfini et se compose d'une unité inférieure de metabasaltes et de roches pyroclastiques et sédimentaires associées (roches métavolcaniques de Faribault Brook), sur laquelle reposent des roches sédimentaires quartzueuses avec par endroits des conglomérats et des tufs (schiste de Barren Brook), et des schistes semi-pélitiques ou psammitiques (schiste de Dauphinee Brook), qui se transforment progressivement en schistes porphyroblastiques métamorphisés au point de produire du disthène et de la staurotite (schiste de Corney Brook). L'ensemble contient souvent une amphibolite à grain moyen (amphibolite de George Brook), caractérisée par une structure dioritique résiduelle; elle représente vraisemblablement des intrusions synvolcaniques. Le gneiss de Belle Cote Road, un orthogneiss tonalitique ou granodioritique de l'Ordovicien-Silurien qui fait partie du complexe de Pleasant Bay, forme une zone allongée dans la partie centrale des hautes-terres. On peut suivre ces unités à partir de la rivière Cheticamp jusqu'à dans la partie centrale des hautes-terres, dans la zone limitée par les chemins Highland et Fielding. Ces unités sont coupées par une gamme de roches granitoïdes feuilletées ou non déformées du Silurien ou du Dévonien. Des gisements de sulphures massifs sont communs près de Faribault Brook; on en trouve par endroits près de la zone de transition séparant les roches métavolcaniques et les roches métasédimentaires. Les sulphures de certains gisements ont été déplacés par cisaillement; d'autres gisements sont associés à des zones de cisaillement distinctes plus récentes. On ne connaît pas l'âge des roches-mères volcaniques et sédimentaires de l'ensemble métavolcanique de Jumping Brook mais, contrairement aux hypothèses antérieures, ces roches pourraient dater du Paléozoïque inférieur.

INTRODUCTION

Metavolcanic and metasedimentary rocks of the western Cape Breton Highlands have long been known to host small polymetallic sulphide deposits (eg. Milligan, 1970; Chatterjee, 1980; Ponsford and Lyttie, 1984), but despite considerable exploration activity no clear consensus exists as to the origin, age, or structural-stratigraphic setting of the deposits (Plint et al., 1986). The current project seeks to combine detailed and regional scale work on the mineral deposits and their host rocks into a coherent structural-stratigraphic framework to serve as a basis for further exploration and study of the mineral deposits, and for correlation with regional studies being carried out concurrently elsewhere in the Cape Breton Highlands (eg. Raeside et al., 1984; Raeside and Barr, in press; Barr et al., 1987).

Prior to this study, regional mapping in the Cheticamp River and adjacent regions by the GSC (McLaren, 1955; Currie, 1975, 1982, in press) and reconnaissance work in the southern Highlands (McNabb et al., 1976; Jamieson and Craw, 1983) had delineated the major rock units. However, detailed work was confined to the immediate vicinity of the mineral deposits on Faribault Brook (eg. Chatterjee, 1980) and exposures along the Cheticamp River (Craw, 1984). Fieldwork in 1985 (Plint et al., 1986; Connors, 1986) demonstrated a pre-tectonic origin for several sulphide deposits in the Faribault Brook area, and documented their spatial association with tholeiitic metabasalts and felsic tuffs. A syngenetic origin was therefore considered likely for at least some of the deposits.

In 1986, mapping of the southwestern and central Cape Breton Highlands was carried out at 1:10 000 and 1:25 000 with the object of determining how far to the south and east units recognized in the northwestern part of the region could be extended. The work focused on two areas south of Cape Breton Highlands National Park: the Faribault Brook - Rocky Brook belt between the Cheticamp River and the Northeast Margaree River, and the central highlands belt between the Northeast Margaree River and Highland Road (Fig. 1, in pocket).

Although detailed work on the Faribault Brook - Rocky Brook belt and its mineral deposits is still in progress, significant results of local and regional importance are already apparent. The prediction that the Rocky Brook area represents the southern extension of the Jumping Brook - Faribault Brook belt has been confirmed, and a stratigraphic framework for the region as a whole established. An unexpected result was the recognition, in the central highlands in a belt of rocks previously referred to as "gneiss", of nearly the complete range of low-, medium- and high-grade rocks recognized in the Cheticamp River area. The previous interpretation of the volcanic rocks as late Proterozoic (eg. Jamieson and Craw, 1983; Plint et al., 1986) has been called into question; the Lower Paleozoic age postulated by Currie (1982) now seems much more likely. In order to facilitate discussion of the rocks in their regional framework, some revision of nomenclature is required.

Nomenclature

Nomenclature in the Cape Breton Highlands is confusing and inconsistent - units comparable in scale, lithological variation, and metamorphic grade are variously referred to as "Group" (eg. Money Point Group; Macdonald and Smita, 1980), "Formation" (eg. MacMillan Flowage Formation; Raeside and Barr, in press), or "Complex" (eg. Jumping Brook Complex; Currie, 1982, in press). The mineral deposits of the Faribault Brook area occur within a belt of low-, medium-, and high-grade metamorphic rocks, predominantly of sedimentary or volcanic origin, with minor meta-plutonic rocks. Primary structures are generally absent or strongly modified by deformation and metamorphism. The rocks described in this paper are therefore *lithodemic units* according to Articles 31 and 33 of the Stratigraphic Code (North American Commission on Stratigraphic Nomenclature, 1983) and should be named accordingly. The appropriate term on the scale considered here is "Suite" (Article 35) with descriptive lithological names (eg. "Schist") applied to its subdivisions (Article 33, 40), rather than the equivalent terms "Group" and "Formation", which should be applied to metamorphic rocks only where primary features dominate (Article 24(h)). Since unmetamorphosed sedimentary and igneous rocks in the area are separated from metamorphic rocks in the following discussion, the term "Complex" is also inappropriate (Article 37), and obscures systematic variations within the belt.

On these grounds, some revision of nomenclature for metamorphic rocks of the western Cape Breton Highlands is necessary. Rocks in the study area have been termed the "Jumping Brook Complex" by Currie (1982; in press) and included within the informally named "western Highlands volcanic-sedimentary complex" by Barr et al. (1985). However, as noted above, the term "complex" is not appropriate. We therefore suggest the term "Jumping Brook metamorphic suite" for the metavolcanic and metasedimentary rocks of the western highlands, and include within the suite the Jumping Brook Complex of Currie (1982; in press) and correlative rocks farther to the south and east. Most of the rock types included within the Jumping Brook metamorphic suite are well exposed on the Cheticamp River or its tributaries, and the Cheticamp River is therefore proposed as a reference section. The nomenclature proposed in this paper is intended to be used informally until the current project is complete, since some changes may yet arise from detailed studies in progress. We also suggest the term "western Highlands volcanic-sedimentary complex" be avoided and local names used, until such time as correlations and nomenclature within the belt are clarified. Extension of this approach to metamorphic rock units elsewhere in the Cape Breton Highlands is desirable but beyond the scope of the present study.

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LITHOLOGY

Cambrian or older

Foliated plutonic and metamorphic rocks (unit 1)

A few small areas of foliated diorites and quartz-feldspathic schists are present in the southwestern highlands between the Northeast Margaree River and Forest Glen Brook (Fig. 1). The rocks are highly sheared and contain coarse retrograde muscovite. Some are clearly dioritic but others could be granitic or gneissic in origin. South of Forest Glen Brook, they are intruded by the Cambrian Cheticamp Pluton, but their age and tectonic significance are otherwise unknown. A small body of variably foliated granodiorite between Faribault Brook and the upper reaches of Fisset Brook (Fig. 1), considered an outlier of the Cheticamp Pluton by G. Woods (personal communication, 1986), has been included with the older rocks here, following the usage of Barr et al. (1986), who separated it from the Cheticamp Pluton on the basis of its field appearance and distinctive petrography and chemistry (S.M. Barr, personal communication, 1986).

Cheticamp Pluton (unit 2)

This granodiorite to monzogranite pluton has been well described by Barr et al. (1986). The pluton has major local and regional significance for two reasons – its well established Cambrian age (Cormier, 1972; Jamieson et al., in press; Barr et al., 1986) and nonfoliated character apparently establish an upper age limit for the volcanic and sedimentary rocks in the area, and the mineral deposits of the Faribault Brook area are spatially associated with the northeastern contact of the pluton (Fig. 2). A special attempt was therefore made to examine the contact relations of the pluton with the Jumping Brook metamorphic suite. The results are described under "age" below.

Silurian or older

Jumping Brook metamorphic suite (unit 3)

The Jumping Brook metamorphic suite comprises a belt of low-, medium-, and high-grade metasedimentary, metavolcanic, and metaplutonic rocks extending from north of Jumping Brook to the Central Highlands west of Highland Road (Fig. 1). It is bounded on the west by faults against the Cheticamp Pluton and late Devonian to Carboniferous vol-

canic and sedimentary rocks, on the east by complex tectonic and locally gradational contacts with gneissic and plutonic rocks of the Pleasant Bay Complex (Currie, 1975, in press; Craw, 1984; Plint et al., 1986), and separated from probably equivalent rocks of the Crowdis Mountain – Middle River area (Jamieson and Doucet, 1983) by shear zones and later intrusions. It can be subdivided into several lithological units, most of which are exposed on, or near, the Cheticamp River.

Faribault Brook metavolcanics (unit 3a)

Fine grained, massive to well foliated, mafic to intermediate metavolcanic rocks form the structurally lowest unit of the Jumping Brook metamorphic suite. In the middle reaches of Faribault Brook, tholeiitic metabasalts predominate, and possible relict pillow structures are preserved (Connors, 1986; Plint et al., 1986). Farther south, in the area between Turner Brook and Rocky Brook South, massive mafic rocks pass upwards into intermediate metavolcanics with associated fine grained sediments and minor lapilli tuff.

Barren Brook schist (unit 3b)

Between Rocky Brook and Jim Campbell's Brook, a heterogeneous assemblage of relatively coarse grained metasedimentary rocks structurally overlies the Faribault Brook metavolcanics (Fig. 1). Boulder conglomerate outcropping along Rocky Brook and in a small area south of Faribault Brook (Fig. 1) contains large, rounded clasts of granite and diorite in a dark green, highly feldspathic matrix. Granite boulders in the conglomerate commonly contain large, equant, bluish quartz phenocrysts that may be the source of the quartz "eyes" common in the associated finer grained metasedimentary rocks; some granite boulders closely resemble the nearby Cheticamp Pluton. North of Rocky Brook, quartz pebble and shale chip metaconglomerate, quartz-sericite schist, and minor quartzite are common; similar fine- to medium grained, quartz-rich schists occur in the vicinity of Faribault Brook and on the west side of Sugarloaf Mountain (Fig. 1). Their protoliths probably included some felsic pyroclastic rocks (Connors, 1986), as well as silicic volcanogenic sediments. The foliation varies in intensity, from well defined in finer grained lithologies to poorly defined in the boulder conglomerates.

Dauphinee Brook schist (unit 3c)

Well foliated, grey, fine- to medium-grained pelitic, semipelitic, and psammitic schists outcrop on Dauphinee Brook, the lower part of Faribault Brook, and the surrounding hillsides (Fig. 1). They are lithologically similar to schists exposed north of the Cheticamp River along Jumping Brook, Corney Brook, Trout Brook, and the Cabot Trail (Currie, 1982, in press; Conrod, 1984; Plint et al., 1986). On Faribault Brook, these metasediments structurally overlie metabasalts and quartz-sericite schists. The well defined compositional layering in these schists is interpreted as transposed bedding,

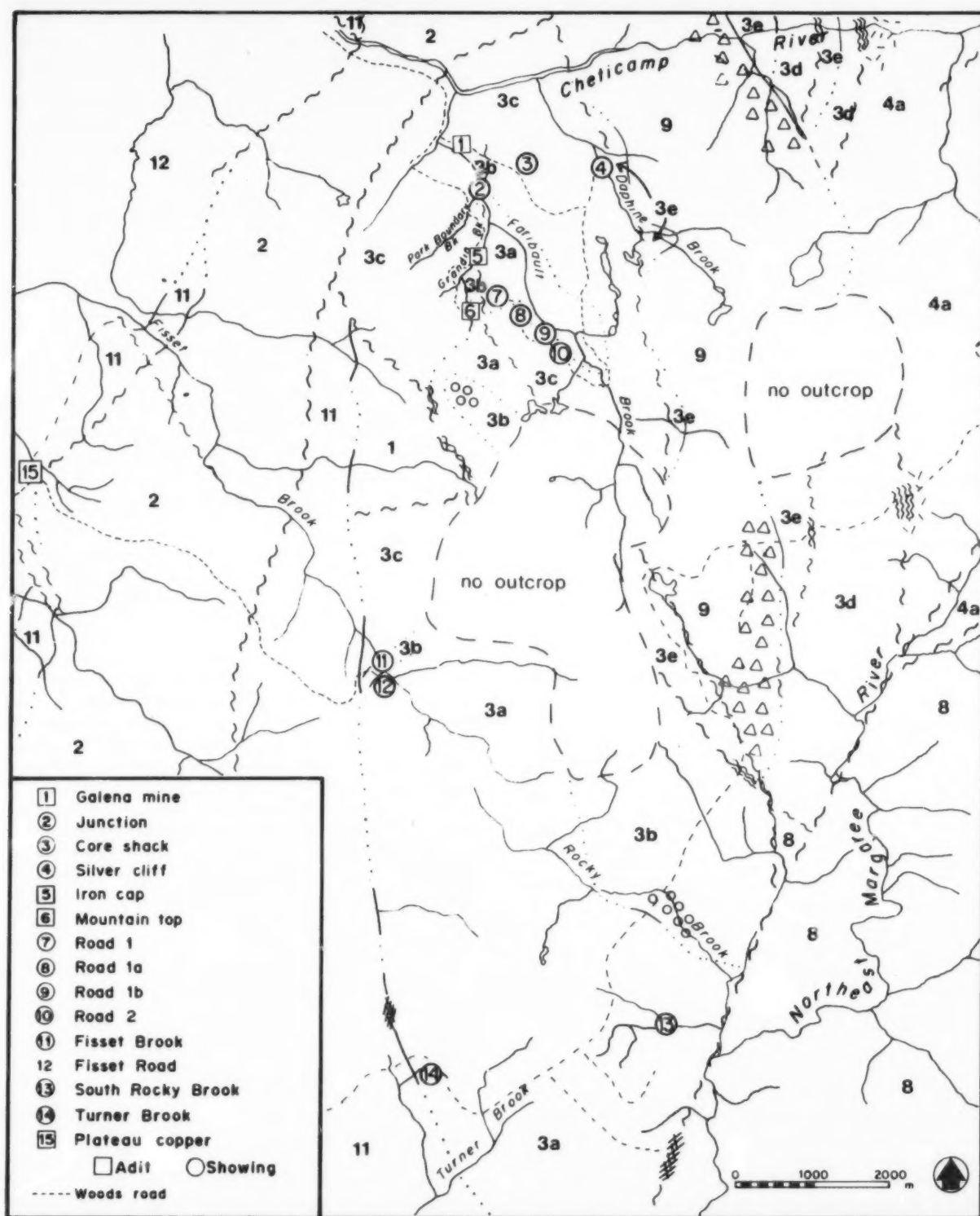


Figure 2. Northwestern part of the map area shown in Figure 1, showing the locations of the most important mineral deposits. Unit numbers and symbols as for Figure 1.

on the basis of tight to isoclinal folds of this layering with axial surfaces parallel to the pervasive foliation (Connors, 1986). Rarely, graded bedding is preserved, but the tight folding makes this an unreliable indicator of younging direction for the sequence as a whole. Fine grained, semi-pelitic to psammitic schists in the central highlands (Fig. 1) are tentatively included with this unit on the basis of similar metamorphic grade and lithology. The Faribault Brook metavolcanics, Barren Brook schist, and Dauphinee Brook schist, all have a greenschist facies mineralogy and are equivalent to the "low grade belt" mapped along the Cheticamp River by Craw (1984).

Corney Brook schist (unit 3d)

Medium- to high-grade pelitic and semi-pelitic schists, with minor marble and psammite, occurring on the Cheticamp River, Corney Brook, the northeastern end of Jumping Brook, and the central highlands near Calumruadh and Coinneach brooks, are referred to here as the Corney Brook schist. This unit is equivalent to the "medium grade belt" of Craw (1984). Pelitic and semi-pelitic members of the unit characteristically contain coarse staurolite, biotite, and garnet porphyroblasts, with kyanite at the highest grade, in a phyllitic to schistose matrix. Medium- to high-grade marbles, quartzites, albite schists and hornblende recognized in the Corney Brook area (Plint et al., 1986) have not yet been identified south of the Cheticamp River. Centimetre- to metre-scale compositional layering, folded by tight to isoclinal folds, is interpreted as transposed bedding. Based on bulk compositions and rare relict primary textures, the Corney Brook schist is interpreted to have formed as a suite of clastic sediments interlayered with felsic tuffs and minor basic flows – that is, it appears to represent the higher grade equivalents of units 3a–3c.

George Brook amphibolite (unit 3e)

Medium- to coarse-grained metabasite, commonly with relict dioritic texture, occurs north of the present area on George Brook and Corney Brook, as well as on the Cheticamp River, Jim Campbells Brook, and in the central highlands north of Second Forks Brook (Fig. 1). It typically contains coarse hornblende porphyroblasts in a finer grained plagioclase-biotite-quartz matrix. Although its contacts range from concordant to discordant, the foliation in the amphibolite is generally parallel to that in the surrounding metasediments, indicating that they shared at least one phase of deformation. The distribution of these amphibolites suggests that they were intrusive into the sedimentary rocks of the belt, and perhaps represent the subvolcanic equivalents of the mafic metavolcanic rocks. Where strongly sheared, these amphibolites are easily confused with mafic schists of the Faribault Brook metavolcanics and foliated diorite plutonic complexes of the eastern Cape Breton Highlands (eg. Raeside et al., 1984; Barr et al., 1985). This has led to considerable confusion in existing maps, and it is possible that some rocks are still incorrectly assigned; this can only be rectified by further detailed work.

Pleasant Bay Complex (unit 4)

The Pleasant Bay Complex, defined by Currie (in press) in the northern highlands, has been recognized as far south as Fielding Road (Fig. 1). It includes tonalitic to granodioritic orthogneiss, amphibolite, pelitic gneiss, and a variety of foliated granitic rocks and pegmatites which at the present scale of investigation cannot be easily separated from the gneisses. The Pleasant Bay Complex south of the Cheticamp River is dominated by orthogneiss, referred to as the Belle Cote Road gneiss by Jamieson et al. (in press).

Belle Cote Road gneiss (unit 4a)

Tonalitic to granodioritic orthogneiss occurs on Belle Cote Road south of Cape Breton Highlands National Park, and also underlies a large part of the central highlands in the vicinity of First Fork and Second Fork brooks (Fig. 1). It consists mainly of coarse- to medium-grained, banded, white to grey, biotite-plagioclase gneiss, but where strongly sheared consists of dark grey, fine grained, biotite-rich schist. It is locally associated with foliated pegmatite, aplite, and medium grained granitic rocks, some of which may be dykes from the Park Spur Pluton. Although it is generally well banded and thus referred to as a gneiss rather than a pluton, an intrusive origin can be inferred for a large part of this unit, based on textural and mineralogical criteria, and discordant contacts in the central highlands near Second Fork Brook (Fig. 1). Minor coarse pelitic schists within the orthogneiss appear to be tectonic or xenolithic inclusions of the Jumping Brook metamorphic suite; locally abundant amphibolite may represent mafic plutonic layers or inclusions of Jumping Brook metamorphic suite metabasites. A sample of tonalitic orthogneiss from Belle Cote Road yielded igneous and metamorphic zircon fractions (Jamieson et al., in press) dated at 433 ± 20 Ma (Late Ordovician – Silurian). The Belle Cote Road gneiss thus underwent high grade metamorphism and deformation during, or soon after, its emplacement, and provides an important constraint on the timing of regional tectonic activity.

Silurian – Devonian

Taylor's Barren Pluton (unit 5)

A distinctive belt of variably foliated, pink granitoid rocks, extending through the central highlands from north of Calumruadh Brook to south of Fielding Road (Fig. 1), is referred to here as the Taylor's Barren Pluton. It is equivalent to, and includes, the coarse grained foliated granitoid rocks of the Egypt Highland Unit described by Jamieson and Doucet (1983). It typically consists of well foliated augen granite, with protomylonitic to mylonitic textures developed locally, especially in the vicinity of Calumruadh Brook. Weakly foliated aplite is common and gradational into the other rocks. The tectonic significance of the mylonite zones and their age relative to other structures is not known. Its western margin is poorly exposed, but it is apparently cut by the Margaree Pluton. A major north-northeast – trending fault bounds the pluton on the east. Although it is approximately

parallel to the general trend of the mylonite zones, it locally cuts the mylonite, and displays strongly cataclastic textures; it is therefore a later and possibly unrelated structure. Samples from the least deformed and altered part of the pluton, in the vicinity of Maggie Randal's Brook, define an Rb-Sr whole-rock isochron of 419 ± 17 Ma (Gaudette et al., 1985), consistent with field evidence showing that the pluton is younger than the Belle Cote Road gneiss and older than the West Branch North River Pluton.

Park Spur Pluton (unit 6)

Foliated, fine- to medium-grained, homogeneous biotite-muscovite granite underlies the northeastern corner of the study area (Fig. 1). Its foliation trends nearly east-west, in contrast to the north-south to northeast-southwest foliations characteristic of the central highlands belt. It is bounded on the south by shear zones against foliated diorite, and on the west by major faults. Its age of intrusion is unknown, but muscovite from the pluton has yielded an Rb-Sr cooling age of about 370 Ma (Jamieson et al., in press). It may be a foliated equivalent of the Devonian White Point pluton of the northeastern Highlands (S.M. Barr, personal communication, 1986; Barr et al., 1987).

Devonian - Carboniferous

West Branch North River Pluton (unit 7)

The West Branch North River Pluton is an early Devonian (400 ± 5 Ma) hornblende-biotite granodiorite to monzogranite that cuts schists and gneisses in the southeastern part of the area. It has been described by Jamieson and Doucet (1983) and O'Beirne-Ryan and Jamieson (1986); no further work has been done in this study.

Margaree Pluton (unit 8)

The Margaree Pluton is a large, megacrystic, hornblende-biotite monzogranite that trends north-south through the central part of the study area (Fig. 1) and extends to the north through the Cape Breton Highlands National Park (Barr et al., 1987). Numerous porphyritic dykes from this pluton cut the adjacent rocks. Its petrology, geochemistry, and age have been discussed by O'Beirne-Ryan et al. (1986). It cuts most other units in the area, and shows a few kilometres of dextral offset along northeast-trending fault zones in the upper reaches of the Northeast Margaree River (Fig. 1).

Salmon Pool Pluton (unit 9)

Fine- to medium-grained, homogeneous, undeformed syenogranite cuts metamorphic rocks along the Cheticamp River and has been traced to the south as far as Jim Campbell's Brook (Fig. 1). It appears to be fault-bounded on its western margin (Craw, 1984), but its eastern margin is marked by an intrusion breccia of microgranite intruding fine grained mafic rocks (Fig. 1). In the vicinity of Jim Campbell's Lake, the mafic inclusions are diabase rather than metabasite. This

suggests that the pluton is part of a bimodal igneous suite, which together with a zircon date of 365 ± 5 Ma (Jamieson et al., in press), is consistent with the interpretation that it was subvolcanic to the Fisset Brook Formation. The Salmon Pool Pluton is similar to other syenogranites in the southern highlands, including parts of "Leonard McLeod Brook complex" in Middle River area (Jamieson and Doucet, 1983) and biotite microgranite on Sugarloaf Mountain (S.M. Barr, personal communication, 1986).

Miscellaneous undeformed granitoid rocks (unit 10)

Small granitic intrusions of unknown age occur on MacLean Brook, Sugarloaf Mountain, and in the central highlands belt. They are generally undeformed, although locally highly altered, and may be related to Devonian intrusions in the region (West Branch North River or Margaree plutons). However, no clear correlations are possible at this stage of the investigation.

Fisset Brook Formation (unit 11)

The Fisset Brook Formation extends through the western part of the study area from Aucoin Brook to Forest Glen Brook, with small outliers near Sugarloaf Mountain. It consists of Upper Devonian to Lower Carboniferous basalts, rhyolites, and redbeds (eg. Blanchard et al., 1984). Its contact with the Jumping Brook metamorphic suite northeast of Forest Glen Brook appears to be a syndepositional fault zone. A complete gradation of textures from coarse sedimentary breccia and agglomerate to fault breccia occurs near Turner Brook; angular fragments from the fault zone can be found as clasts in overlying volcanic-sedimentary breccia. The Faribault Brook metavolcanics are strongly sheared near the fault and veins of massive, milky quartz, with rare copper mineralization, are common.

Carboniferous sedimentary rocks (unit 12)

Carboniferous sedimentary rocks of the Horton and Windsor groups occur in the valley of the Northeast Margaree River north and south of Sugarloaf Mountain; a small area of Horton Group arkose and conglomerate overlies the Fisset Brook Formation on Forest Glen Brook (Fig. 1). These rocks are generally faulted against older units, and have not been mapped in detail.

STRUCTURE AND METAMORPHISM

Primary structures are locally preserved in the Jumping Brook metamorphic suite, including relict pillows in metabasalts on Faribault Brook, sedimentary layering in the Dauphinee Brook schist, and clastic texture in the boulder conglomerate and some pyroclastic rocks. However, these structures are generally overprinted by metamorphic fabrics, and are useful more as a clue to the origin of the rocks than as indicators of stratigraphic younging directions.

The rocks have suffered several phases of ductile to brittle deformation, some of which are composite. The earliest phase, D_1 , produced tight to isoclinal folds of layering in metasedimentary rocks. The main foliation, S_1 , is parallel to the axial surfaces of these folds and is also generally parallel to compositional layering except in fold hinges. Bedding is commonly transposed along S_1 . Small veins commonly cut this foliation and are themselves folded by close to tight folds with axial surfaces parallel to the earlier foliation. This suggests that the early tight folding was followed by a phase of coaxial flattening, probably during a single episode of progressive deformation. Prograde metamorphism accompanied this deformation, with the main phase of porphyroblast growth postdating the veining and synchronous with the flattening (Connors, 1986). In the Faribault Brook area, the main foliation is shallow dipping, suggesting that the early structures were recumbent, however, the effects of later deformation have not been worked out.

The second phase of deformation, D_2 , produced the prominent north-trending crenulation lineation characteristic of the Cheticamp River area, and was probably associated with the development of major north-trending antiforms (Conrod, 1984; Craw, 1984; Connors, 1986). The lineation postdates the development of the D_1 porphyroblasts and is locally accompanied by some retrogression. North-trending, high temperature shear zones on the Cheticamp River (Craw, 1984) and on Belle Cote Road south of LeBlanc Brook (Fig. 1), have resulted in west-to-east stacking of progressively higher grade rocks over lower grade ones, possibly during the late stages of D_2 .

Numerous low grade ductile shear zones in the area are assigned to D_3 , since they postdate the development of the north-trending antiforms and high grade shear zones, but are cut by later brittle faults and cataclastic zones. Kink bands, common in the vicinity of Faribault Brook, which postdate the D_2 crenulation lineation and shear zones, but predate many of the faults in the region, may have formed at about this time. These shear zones are particularly important in the central highlands belt, where they disrupt the metamorphic sequence and are associated with growth of coarse retrograde muscovite and chlorite. Mineralized shear zones in the Faribault Brook area, and mylonites in the Taylor's Barren Pluton, are at about the same metamorphic grade and may have formed at this stage.

The final stage of deformation, D_4 , involved extensive faulting on northeast-trending fault zones, of which the Northeast Margaree Fault Zone is the most important. It probably represents the southern extension of the Aspy Fault and cuts all rocks in the area, including Devonian - Carboniferous plutonic and sedimentary rocks. It is generally marked by zones of fault breccia and cataclasite, which can be several hundred metres wide (eg. on Park Spur Road just south of the National Park boundary). A north-trending zone of ultracataclasite, approaching pseudotachylite, 10 m across can be traced for over 1 km on Belle Cote Road (Fig. 1). The sense of displacement on these faults is not always obvious and may have changed through time. However, dextral displacements on the order of several kilometres can be inferred

on north trending faults offsetting the Fisset Brook Formation west of Sugarloaf Mountain, and on northeast-trending faults cutting the Margaree Pluton. Some of the faulting was synchronous with the deposition of the late Devonian Fisset Brook Formation, and faulting continued well into the Carboniferous. The age and significance of the numerous small faults within the study area with respect to the Northeast Margaree Fault Zone are not known.

MINERAL DEPOSITS

The Jumping Brook metamorphic suite hosts numerous small base metal-gold-silver-arsenopyrite prospects and showings, concentrated in low- to medium-grade rocks in the north-western part of the area between Faribault Brook and Rocky Brook (Fig. 2). Work still in progress suggests that mineral deposits within the Jumping Brook metamorphic suite are related to the transition from volcanic to sedimentary rocks and with shearing of rocks in that transition zone. The possible role of the Cheticamp Pluton in the formation of these deposits is discussed below.

The most common single type of deposit is hosted by quartz-sericite schists and fine grained foliated felsites of the Barren Brook schist, especially where this unit forms relatively thin horizons between the Faribault Brook metavolcanics and the Dauphinee Brook schist near Faribault Brook. Typical examples include Galena Mine, Fisset Road, Core Shack, and Mountain Top (Fig. 2). A varied sulphide mineralogy (galena-sphalerite-pyrite-arsenopyrite; minor chalcopryrite-pyrrhotite-argentite) occurs within layers that locally exhibit isoclinal folding. Petrographic investigation (Connors, 1986; Plint et al., 1986) show that at Core Shack and Galena Mine, sulphides predate both deformation and metamorphism.

Less commonly, mineralization is hosted by weakly deformed Dauphinee Brook schist or Faribault Brook metavolcanics in proximity to the Barren Brook schist. Good examples are Silver Cliff and the upper Core Shack showings (Dauphinee Brook schist) and the Junction and Road 2 showings (Faribault Brook metavolcanics; Fig. 2). These showings also display a varied mineralogy (arsenopyrite-pyrite-sphalerite-galena-chalcopryrite) within isoclinally folded layers. Some sericitic alteration and porphyroblast growth are associated with the mineralization. As above, petrographic study suggests that the sulphides were present prior to deformation and metamorphism, and their origin is probably similar to the deposits within the Barren Brook schist. Later shear zones locally disrupt massive sulphide layers, causing some remobilization of sulphides.

Within the Faribault Brook metavolcanics, shear zones in metabasite commonly host sulphides (eg. Road 1, Road 1a, and Road 1b showings; Fig. 2). The mineralogy is generally quite simple and dominated by arsenopyrite concentrated along shear planes. Sericite alteration and garnet porphyroblasts are also associated with these showings. The common lack of arsenopyrite in the immediately adjacent rocks, and of mobile sulphides in the shear zones, suggests

that the arsenopyrite was not remobilized from the existing showings but was introduced at a later date.

In summary, pre-metamorphic and pre-deformation showings in the Jumping Brook metamorphic suite are concentrated in the vicinity of the transition from mafic volcanic to sedimentary rocks, and are especially common in quartz-sericite schists of the Barren Brook schist. Showings on Rocky Brook South, in metasedimentary rocks near the top of the volcanic unit, are in a similar stratigraphic setting. This suggests a primary stratigraphic control, and a syngenetic or early epigenetic origin for the deposits. However, interpretation is complicated by the effects of later deformation, which has locally remobilized sulphides in these zones. Arsenopyrite-dominated, shear-hosted sulphide deposits in metabasites of the Faribault Brook metavolcanics do not appear to be directly related to the others.

Scattered showings and mineralized zones are common elsewhere in the region. Silicified, rusty weathering, brecciated rhyolites occur in a small area between Turner Brook and Rocky Brook South. Owing to poor outcrop, it is not known if these rocks are rhyolite flows within the Faribault Brook metavolcanics, or if they are later intrusions, possibly dykes from the nearby Margaree Pluton. Shear zones throughout the region are commonly associated with massive, milky white quartz veins, that locally contain small amounts of sulphide and rare supergene copper enrichment. These are particularly common in the fault zone between the Fisset Brook Formation and Faribault Brook metavolcanics near Turner Brook, and in shear zones cutting foliated diorites (George Brook amphibolite) in the central highlands northeast of Calumruadh Brook. Minor copper (native Cu, chalcopryrite, and malachite) mineralization also occurs in the Fisset Brook Formation in vugs and fractures.

AGE

Although the ages of pluton intrusion and cooling of metamorphic rocks are fairly well constrained (Gaudette et al., 1985; O'Beirne-Ryan et al., 1986; O'Beirne-Ryan and Jamieson, 1986; Barr et al., 1986; Jamieson et al., in press) there is still little agreement on the depositional age of the Jumping Brook metamorphic suite protoliths, with consequent uncertainty concerning the times of deformation, metamorphism, and mineralization.

Deposition of volcanic and sedimentary protoliths

There are two schools of thought: that these rocks are late Precambrian, or that they are lower Paleozoic. A late Precambrian age is supported by the presence in the southeastern and northwestern highlands of known Precambrian to Cambrian plutons (Barr et al., 1985; Barr et al., 1986), by the relative lack of deformation of the Cheticamp Pluton compared with the Jumping Brook metamorphic suite, and by a presumed intrusive contact between the Cambrian Cheticamp Pluton and metavolcanic rocks east of Cheticamp. If that intrusive contact exists, the Jumping Brook metamorphic suite protoliths could be no younger than 550 Ma

(zircon crystallization age of Cheticamp pluton, Jamieson et al., in press). On the other hand, no Precambrian radiometric date has yet been obtained from within the Jumping Brook metamorphic suite, and there are significant lithological differences between these rocks and Precambrian rocks elsewhere in the Cape Breton Highlands (Barr and Raeside, in press). Zircon dates on tonalitic orthogneiss and rhyolite dykes indicate considerable igneous activity in the area in the late Ordovician to Silurian (Currie, 1982; Jamieson et al., in press), despite the difficulty of tying these dates directly to a depositional age for the Jumping Brook metamorphic suite. ^{40}Ar - ^{39}Ar cooling ages on biotite and hornblende and Rb-Sr cooling ages on muscovite (Jamieson et al., in press) indicate cooling between 410 and 380 Ma, with no obvious evidence of resetting.

In the absence of a radiometric or fossil date on a stratigraphic unit within the sequence, the question of the age of deposition must be resolved with respect to the contact relations of the Cheticamp Pluton, which has yielded a Cambrian age in three independent studies (Cormier, 1972; Barr et al., 1986; Jamieson et al., in press). This apparently simple problem is complicated by the largely faulted boundaries of the pluton against the volcanic and sedimentary rocks, faults within the pluton, and poor exposure in critical areas. The pluton clearly intruded foliated and altered dioritic rocks on its southeastern margin (Barr et al., 1985; Barr et al., 1986); however, major faults separate this part of the Cheticamp Pluton from the critical area in the north. A special effort was therefore made to investigate the contact relations of the Cheticamp Pluton with the Jumping Brook metamorphic suite.

The results to date are ambiguous. Felsic horizons within the Dauphinee Brook schist near the mouth of Faribault Brook have been interpreted as granitic dykes with crosscutting contacts (G. Woods, personal communication, 1986). These horizons, however, are strongly foliated and resemble rocks interpreted as felsic tuffs in the Crowdis Mountain area (Jamieson, 1981); the apparently crosscutting contact has clearly been modified by faulting and could simply be boudinaged. On woods roads and in trenches south and west of Faribault Brook, strongly sheared metasediments and metabasites are cut by thin, pink, feldspar-rich veins and local quartz-rich veins that could be interpreted as granite veinlets. However, similar veinlets are common in shear zones remote from intrusions, and could thus be hydrothermal (Jamieson and Doucet, 1983). The presence in the Rocky Brook conglomerate of boulders that closely resemble the Cheticamp Pluton suggests that it is not only older than the volcanic sequence, but was a source of coarse detritus during deposition of the Barren Brook schist protoliths. On the other hand, the Cheticamp Pluton, although locally brecciated, altered, and sheared, is not penetratively foliated or metamorphosed. If it is older than the polydeformed metamorphic rocks, an explanation is required for its relative lack of deformation.

These observations allow three possibilities for the relative ages of the Cheticamp Pluton and the Jumping Brook metamorphic suite. 1) The Cheticamp Pluton intrudes the volcanic-sedimentary sequence; the boulders in the Rocky

Brook conglomerate come from a different but superficially similar pluton. 2) The Cheticamp Pluton intrudes the lower part of the volcanic sequence; a major stratigraphic break separates the Faribault Brook metavolcanics from the Barren Brook schist. 3) The Cheticamp Pluton is older than the volcanic-sedimentary sequence and its contacts are entirely tectonic.

Since the Cheticamp Pluton is petrographically unlike any other pluton in the Cape Breton Highlands (S.M. Barr, personal communication, 1986), the boulders in the Rocky Brook conglomerate provide strong evidence that at least the upper part of the Jumping Brook metamorphic suite is lower Paleozoic (post-550 Ma). This is in contrast to our previous interpretations (Jamieson and Crow, 1983; Plint et al., 1986) and supports the interpretation of Currie (1982, in press). It is possible, however, that there is a significant stratigraphic break between the Faribault Brook metavolcanics and Barren Brook schist, although there is no obvious field evidence for this. If the Cheticamp Pluton is older than the Jumping Brook metamorphic suite protoliths, its relative lack of deformation could be attributed to its competence during deformation. Notably, the nearby Belle Cote Road gneiss, which is clearly younger than the Cheticamp Pluton, was deformed under upper amphibolite conditions without affecting the granite. Alternatively, the pluton may not have been in its present position during deformation and metamorphism of the Jumping Brook metamorphic suite. Unfortunately the age of the volcanic and sedimentary rocks will probably continue to be disputed until a radiometric or fossil date is obtained from a unit within the stratified sequence.

Deformation and metamorphism

The relatively undeformed nature of the Cheticamp Pluton has generally been used to infer a Precambrian age for deformation and metamorphism of the Jumping Brook metamorphic suite (Jamieson and Crow, 1983; Plint et al., 1986). As argued above, however, the Cheticamp Pluton may well be older than the metamorphic rocks, and deformation and metamorphism would in this case postdate the intrusion. A further constraint on the timing of tectonism is provided by the zircon date of 433 ± 20 Ma on the Belle Cote Road gneiss (Jamieson et al., in press). Since this was intruded during or just before high grade metamorphism, it is likely that the main episode of tectonic activity in the region occurred in the late Ordovician to early Silurian. This is also supported by the late Silurian – early Devonian cooling ages for metamorphic rocks, and is similar to the timing of tectonism in south-western Newfoundland (Chorlton and Dallmeyer, 1986).

Mineral deposits

As above, this question cannot be fully resolved without clarification of the relations between the Cheticamp Pluton and the Jumping Brook metamorphic suite, and is further complicated by the presence of several types of deposits of different ages. The pre-tectonic polymetallic sulphide deposits associated with the Barren Brook schist presumably formed during, or soon after, deposition of their host rocks,

that is, in Ordovician-Silurian times. However, the timing of remobilization of these deposits in shear zones, and the formation of the shear-related arsenopyrite deposits, is not well constrained, and may be as young as Devonian.

DISCUSSION

The tectono-stratigraphic framework presented here allows for a fairly simple interpretation of relations among the various units in the area, and between these rocks and those elsewhere in the region. The Jumping Brook metamorphic suite is interpreted to have originated as a lower Paleozoic volcanic-sedimentary complex, floored by a marine tholeiitic mafic volcanic sequence (Connors, 1986). The upper part of the sequence consists of felsic volcanic and related sedimentary rocks in the southeast, and mainly semi-pelitic to pelitic clastic rocks, with rare marble and quartzite, in the northwest. The transition from mainly volcanic to mainly sedimentary rocks occurs in the vicinity of Faribault Brook. The centre of felsic volcanism may well have been in the Crowdis Mountain area of the southern highlands, where coarse felsic pyroclastic rocks and flow banded rhyolites occupy a similar stratigraphic position (Jamieson, 1981; Jamieson and Doucet, 1983). Although the Jumping Brook metamorphic suite has been described as if it were a single stratigraphic sequence, it is important to note that stratigraphic and/or tectonic breaks may occur within it.

Early deformation and prograde metamorphism of the Jumping Brook metamorphic suite probably was accompanied by syntectonic intrusion of the Belle Cote Road tonalitic orthogneiss. Metamorphic grade increases towards the orthogneiss from all directions – west to east in the vicinity of the Cheticamp River, northeast to southwest in the central highlands belt, and south to north in the Middle River – Fielding Road area (Jamieson and Doucet, 1983). This strongly suggests that the thermal anomaly causing the metamorphism was associated with the intrusion of the orthogneiss. High grade pelitic rocks associated with the Belle Cote Road gneiss may represent tectonic inclusions or xenoliths within the orthogneiss complex. These relationships suggest that the transition from the Jumping Brook metamorphic suite to the Pleasant Bay Complex, long a controversial subject (eg. Currie, 1982; Plint et al., 1986; Jamieson et al., in press), may be a tectonically modified intrusive contact.

The concentration of mineral deposits near the north-eastern contact of the Cheticamp Pluton has often been interpreted as evidence for a genetic relationship between intrusion and mineralization. Based on the age and stratigraphic arguments discussed above, however, some stratigraphic control seems likely. The occurrence of massive sulphides near the contact of the pluton may be coincidence, or may be related to shearing associated with juxtaposition of the pluton and the schists.

Finally, the association of lower Paleozoic volcanic and sedimentary rocks with syntectonic Ordovician-Silurian tonalite-granodiorite plutons and Devonian – Carboniferous shear zones, bears a strong superficial resemblance to the

geology of southwestern Newfoundland (eg. Currie, 1982; Chorlton and Dallmeyer, 1986; Barr and Raeside, in press). Although direct correlation can only be based on further detailed work, particularly radiometric dating, the analogies are compelling and may suggest further targets for exploration.

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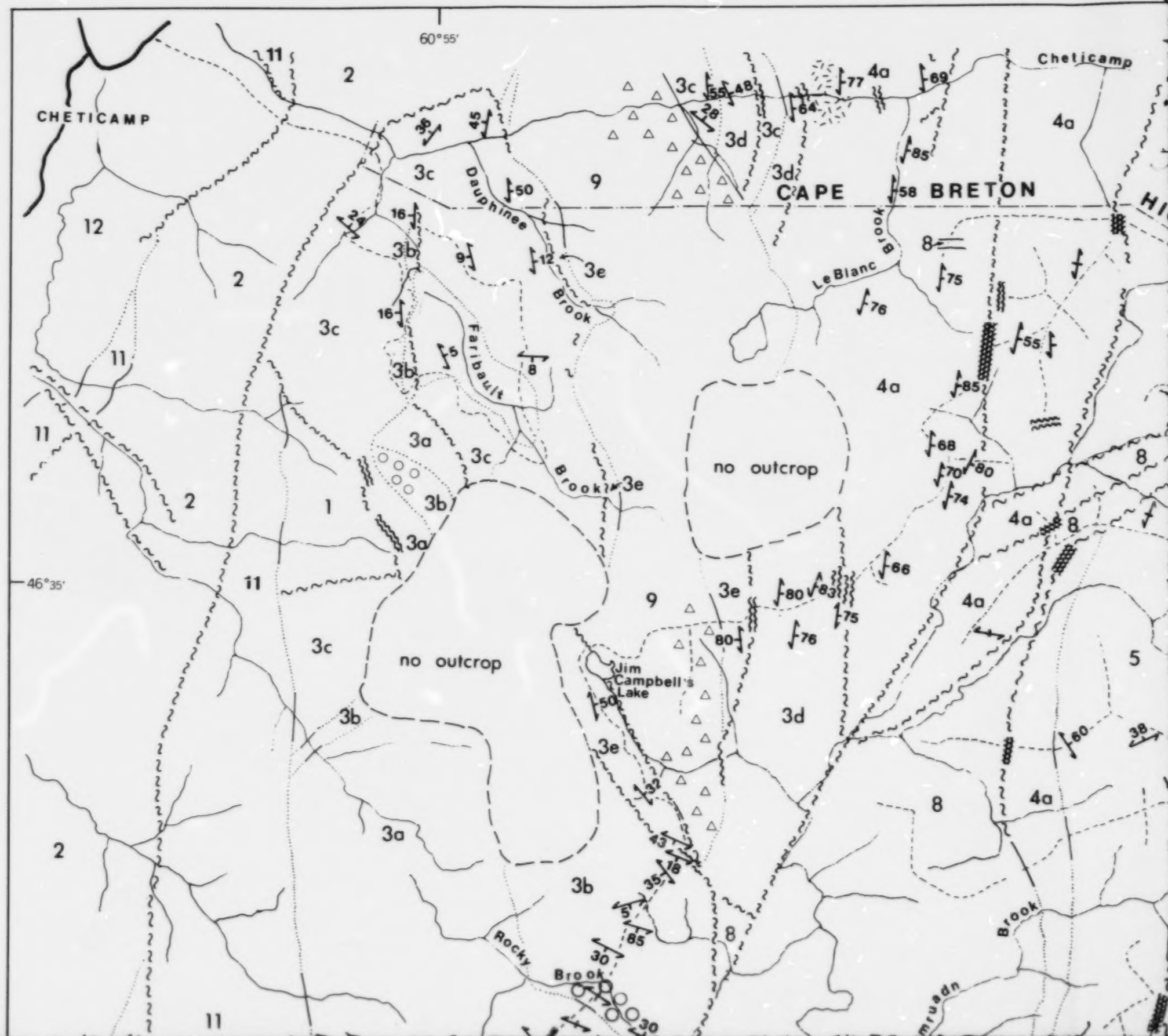
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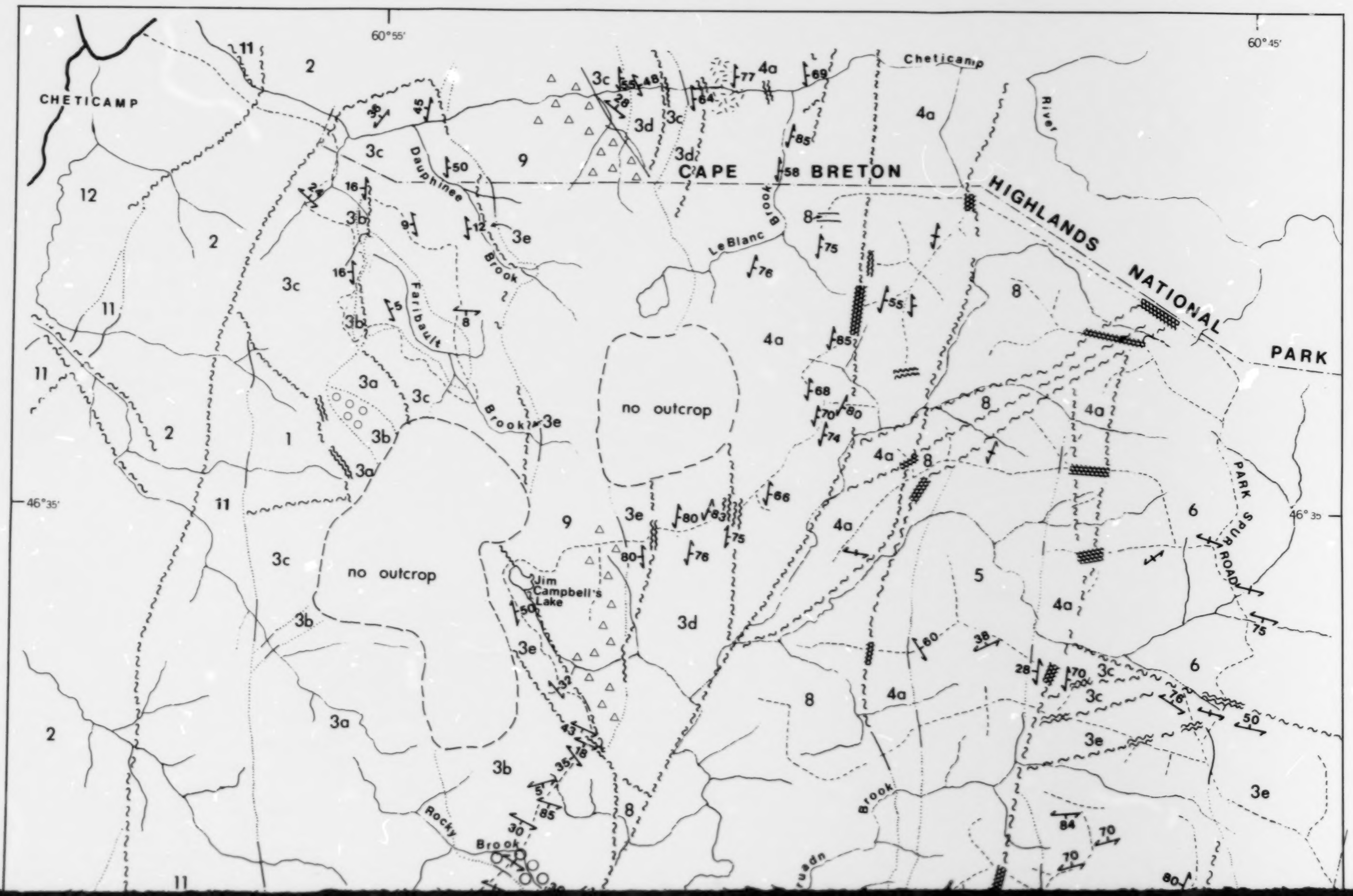
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LEGEND

DEVONIAN - CARBONIFEROUS

- 12 Carboniferous sedimentary rocks
- 11 Fisset Brook Formation
- 10 Miscellaneous undeformed granitoid rocks





LEGEND

DEVONIAN - CARBONIFEROUS

12 Carboniferous sedimentary rocks

11 Fisset Brook Formation

10 Miscellaneous undeformed granitoid rocks

9 Salmon Pool Pluton

▲▲▲▲ Intrusion breccia

8 Margaree Pluton

7 West Branch North River Pluton

SILURIAN - DEVONIAN

6 Park Spur Pluton

5 Taylor's Barren Pluton

SILURIAN OR OLDER

4 Pleasant Bay Complex;
4a Belle Cote Road gneiss

■ Amphibolite

3 Jumping Brook metamorphic suite:
3e George Brook amphibolite
3d Corney Brook schist
3c Dauphinee Brook schist
3b Barren Brook schist
3a Faribault Brook
metavolcanics

○○○○ Boulder conglomerate

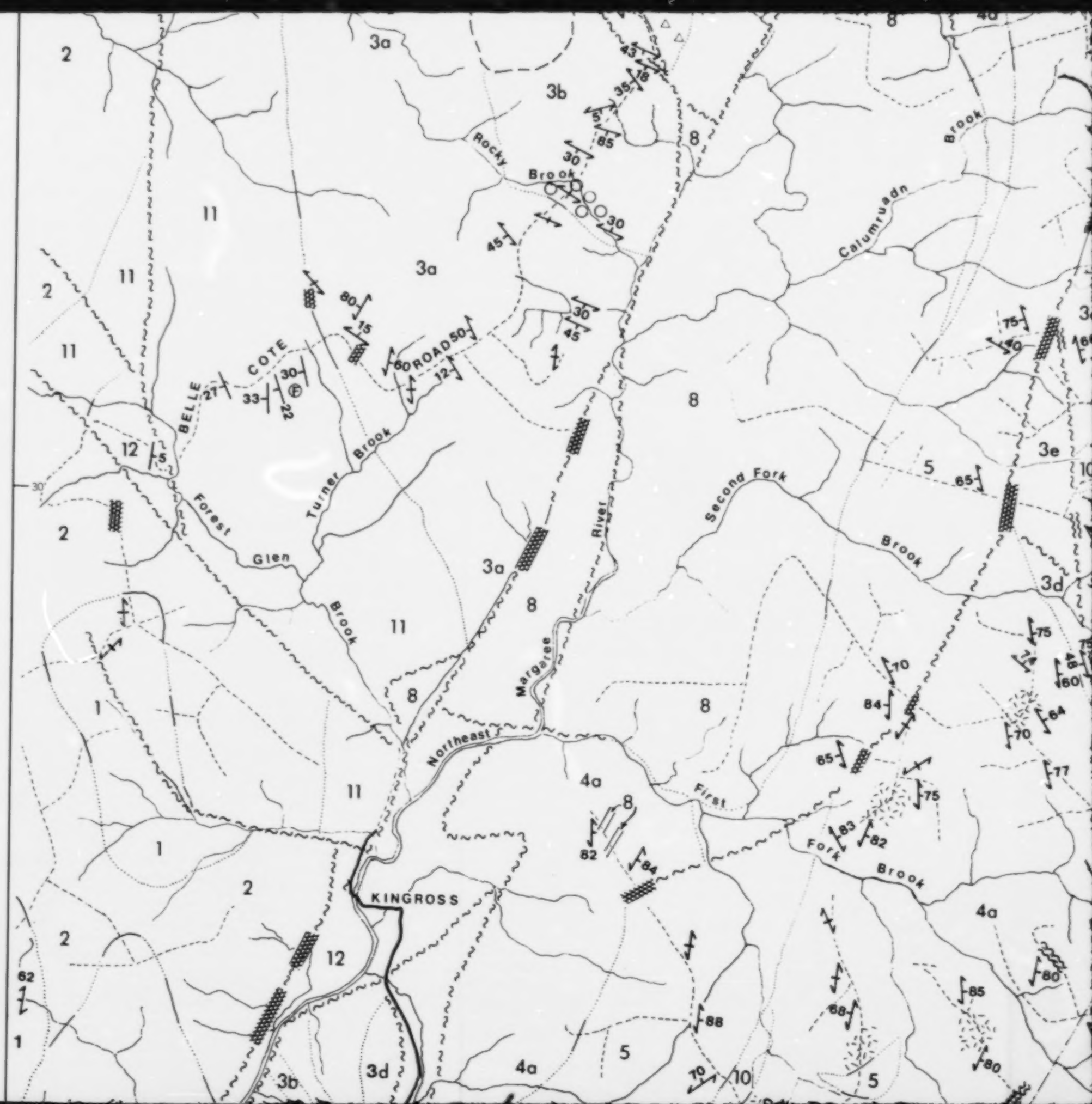
CAMBRIAN

2 Cheticamp Pluton

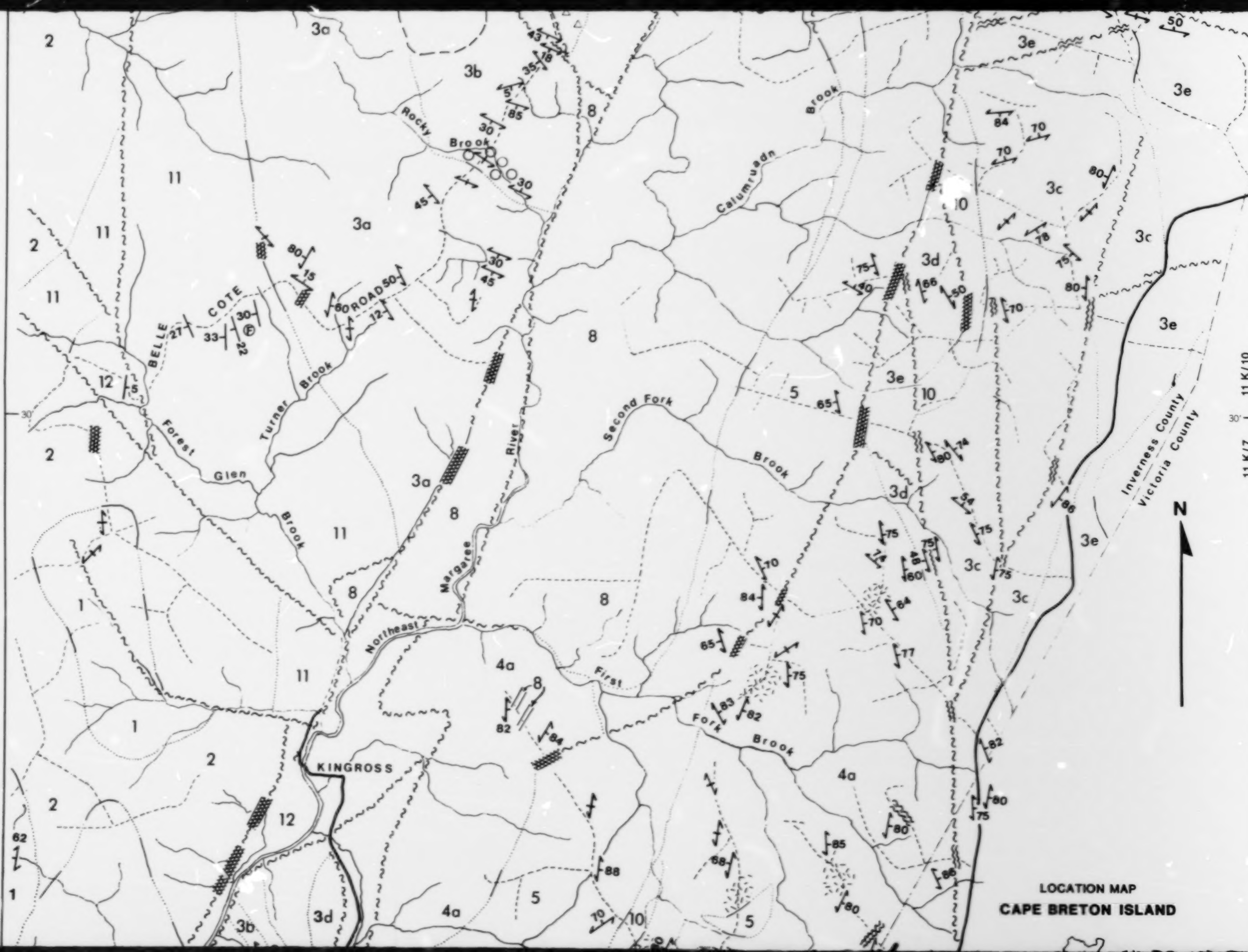
CAMBRIAN OR OLDER

1 Foliated plutonic and metamorphic rocks

Strike and dip of main foliation 50
Strike and dip of bedding 45
Geological contact (observed, inferred)
Cataclastic zone (observed)
Ductile shear zone (observed)
Fault or shear zone (inferred)
Woods road



breccia
te
onglomerate



CAMPORIAN

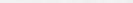
2 Cheticamp Pluton

CAMBRIAN OR OLDER

1 Foliated plutonic and metamorphic rocks

Strike and dip of main foliation 50

Strike and dip of bedding 45

Geological contact (observed, inferred) 

Cataclastic zone (observed)

Ductile shear zone (observed)

Fault or shear zone (inferred)

Woods road

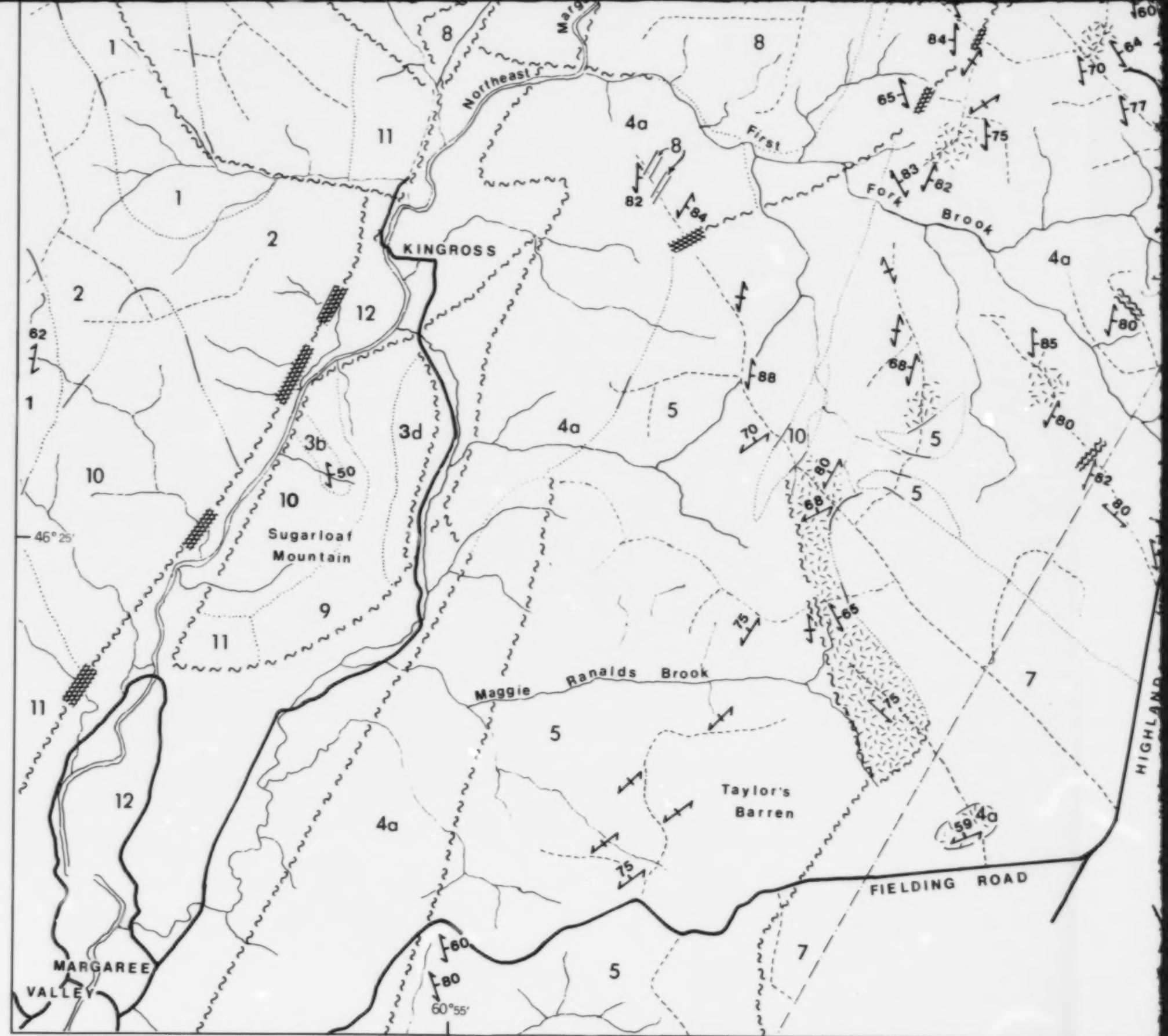


Figure 1. Geology of the west-central Cape Breton Highlands, Nova

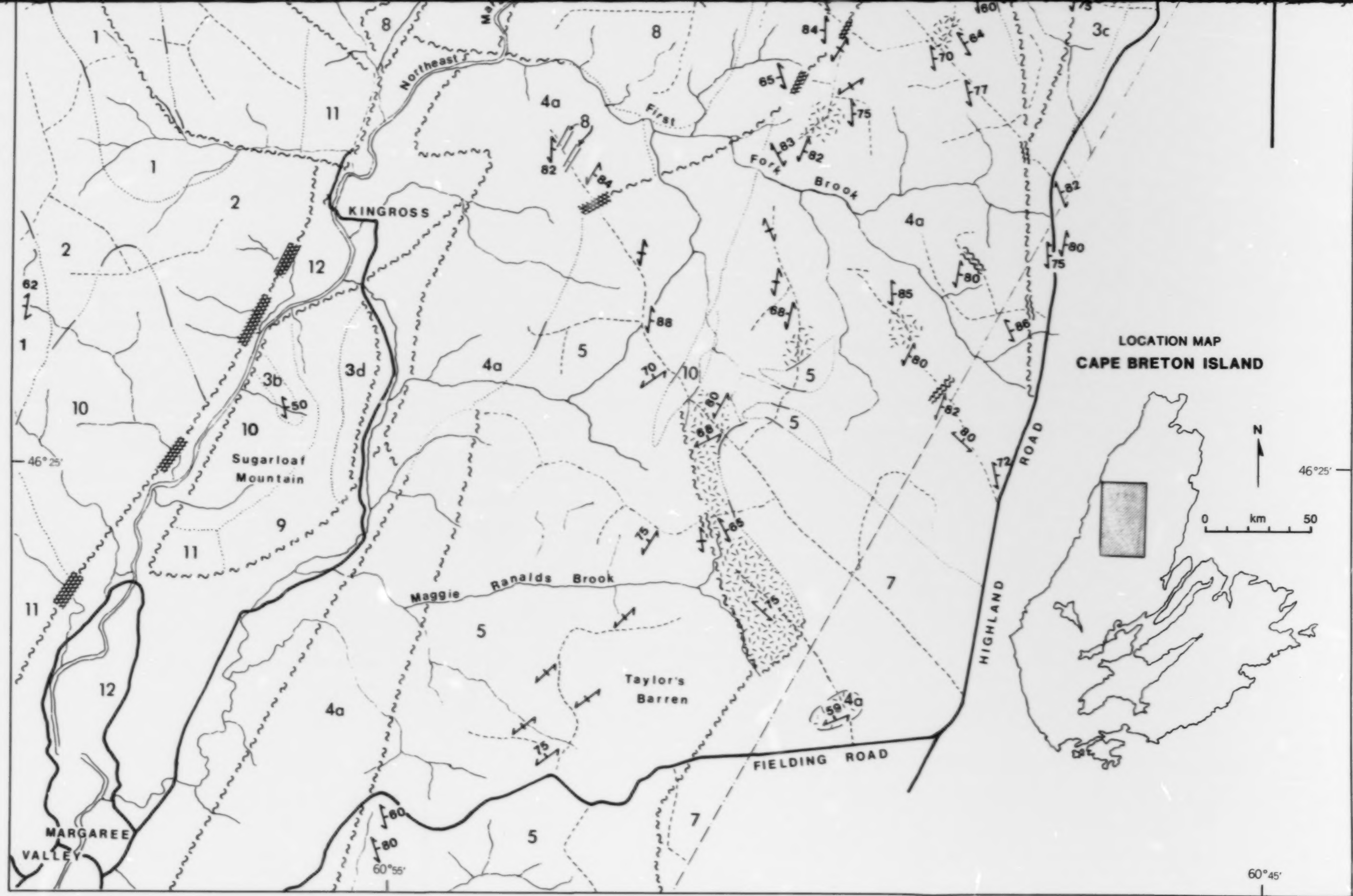


Figure 1. Geology of the west-central Cape Breton Highlands, Nova Scotia